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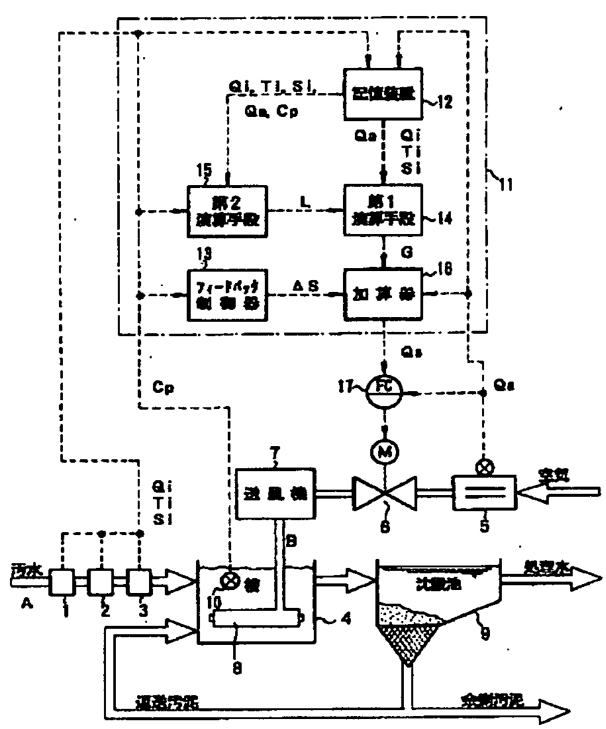
(54)【発明の名称】　汚水処理プラントの送風量制御装置

(57)【要約】

【目的】　急な負荷変動時においても、曝気槽内のＤＯ値を安定的に所定値に保つこと。

【構成】　フィードバック制御器１３において、曝気槽４内のＤＯ濃度とこの目標値に基づいて送風量偏差値が求められる。他方、汚水の流入流量、懸濁物濃度、水温、送風量およびＤＯ濃度に基づいて、第２演算手段１５の第２ニューラルネットワーク機能においてＤＯ濃度が目標値となるような送風量が予測され、予測風量と負荷変動直前の送風量との間の補正量が求められる。第２演算手段１５から第１演算手段１４へ、汚水の流入流量、懸濁物濃度、水温および送風量を入力信号、送風量補正量を出力信号とする教示信号が送られ、第１演算手段１４の第１ニューラルネットワーク機能の学習が行なわれる。第１演算手段１４の第１ニューラルネットワーク機能において、汚水の流入流量、その懸濁物濃度、水温および送風量に基づいて、負荷変動時の送風量補正量が求められ、加算器１６においてフィードバック制御器１３からの送風量偏差量に第１演算手段１４からの補正量が加算される。



【特許請求の範囲】

【請求項１】曝気槽内のＤＯ濃度を一定値に保つよう送風機から曝気槽内への送風量を制御する汚水処理プラントの送風量制御装置において、

曝気槽内のＤＯ濃度とＤＯ濃度目標値とに基づいて送風量の偏差量を出力するフィードバック制御器と、

曝気槽内に流入する汚水の流入流量、その懸濁物濃度、その水温、曝気槽への送風量、および曝気槽内のＤＯ濃度を時系列で記憶するプロセスデータ記憶装置と、

プロセスデータ記憶装置からの汚水の流入流量、その懸濁物濃度、その水温および曝気槽への送風量に基づいて、負荷変動時の送風量の補正量を求める第１ニューラルネットワーク機能を有する第１演算手段と、

汚水の流入流量、その懸濁物濃度、その水温および曝気槽への送風量に基づいてＤＯ濃度を求める第２ニューラルネットワーク機能を有し、プロセスデータ記憶装置からの情報により学習した後、ＤＯ濃度が目標値となるような送風量を予測し、この予測風量と負荷変動直前の送風量との間の補正量を求めるとともに、汚水の流入流量、その懸濁物濃度、その水温および曝気槽への送風量を入力信号、送風量の補正量を出力信号とする教示信号を第１演算手段に出力して第１ニューラルネットワーク機能の学習を行なう第２演算手段と、

第１の演算手段からの送風機の補正量とフィードバック制御器からの偏差量とを加算して送風量を制御する加算器とを、備えたことを特徴とする汚水処理プラントの送風量制御装置。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、活性汚泥を用いた汚水処理プラントの曝気槽のＤＯ濃度を一定に保持するための送風量制御装置に関する。

【０００２】

【従来の技術】活性汚泥を用いて都市下水や工場廃水などの汚水を浄化する汚水処理プラントは、通常、曝気槽と沈殿池（最終沈殿池）から構成されている。

【０００３】多種多様な発生源から集められた汚水は、沈砂、前曝気、前沈殿などの一次処理プロセスで簡易処理されたあと、この汚水処理プラントで二次処理される。

【０００４】すなわち一次処理を受けた汚水は、汚泥処理プラントの曝気槽において沈殿池から返送された返送汚泥と混合接触する。次に曝気された汚水中の酸素と有機物が活性汚泥（以下汚泥と略記する）に吸収されて酸化反応が生じ、これによって汚水が浄化される。

【０００５】また汚泥は酸化反応によって増殖し、増殖した汚泥は沈殿池で固液分離され、大部分は返送汚泥として曝気槽へ返送されるとともに、増殖による増加分は余剰汚泥として引抜かれ、系外に排出される。

【０００６】上記のような水処理プラントにおいては、曝気の条件すなわち曝気槽の溶存酸素（以下ＤＯと略記する）濃度によって、浄化の効果と安定性および送風機のエネルギ消費量が影響される。

【０００７】従って、浄化の効率を高め、かつ過曝気を防止して運転の消費エネルギを節減するためには、曝気槽のＤＯ濃度を一定の値に保つ必要がある。

【０００８】一方、曝気槽のＤＯ濃度は、送風量のほかに流入汚水の性質や運転の条件によって変化し、特に、流入汚水の流量とその懸濁物濃度の負荷変動および水温によって、大きく変化する。

【０００９】ここで図４に、流入の汚水量Q_sが都市下水を浄化する汚水処理プラントでステップ状に変化した時のＤＯ濃度C_pの変化を測定した実験結果の一例を示す。図４（ａ）の実線ａは汚水流量Q_sの変化を示し、図４（ｂ）の実線ｂは曝気槽の略中央のＤＯ濃度C_p変化を送風量と返送汚泥流量を一定で運転した場合について示している。

【００１０】図４（ａ）に示すように、汚水流量Q_sが増加すると懸濁物の負荷が高くなり、酸化のために酸素が消費されてＤＯ濃度ははじめ急降下し、ある時間後すなわちt_1点以降はゆっくりと低下している。これはt_1点の前段と後段ではＤＯ濃度の変化する機構が異なっているからである。

【００１１】すなわち、前段では汚水流量Q_sの増大によって懸濁物負荷量が増大し、汚泥に吸収された懸濁物を酸化するためにＤＯ濃度が低下する。さらに図４（ａ）に示すように、流量が増大すると、汚泥の濃度を低下させるので、ＤＯ濃度は破線ｃ（図４（ｂ））で示す汚泥濃度一定に補正したＤＯ濃度よりは若干低くなっている。

【００１２】t_1点より後段では、前段での機構に加えてさらに次の２つの機構が働く。

【００１３】すなわちt_1点直後にＤＯ濃度が急激に下がるのは、汚水流量の増大によって曝気槽の汚泥が沈殿池に流入し、沈殿池の汚泥量が増大して返送汚泥濃度が高くなるからである。このため高い濃度の返送汚泥が曝気槽に流入して、曝気槽の汚泥濃度（以下ＭＬＳＳと略記する）が高くなって、酸素の消費量が増大する機構が働く。

【００１４】他の機構はt_1点より後段において、全体的にゆっくりとＤＯ濃度が低下している現象を説明するものである。すなわち、懸濁物負荷の増大によって汚泥に吸収された懸濁物が、曝気槽の滞留時間内で完全に酸化されず、返送汚泥中にはまだ酸化されるべき懸濁物を含み、これが次第に蓄積されるという機構が働く。また図４（ｃ）の実線ｄは、返送汚泥の酸素消費速度（以下R_rと略記する）の時間的変化を示している。

【００１５】このように外乱（汚水流量の増大）に対して曝気槽のＤＯ濃度を目標の値に保つための送風量制御装置は、t_1点の前段と後段のＤＯ濃度の変化機構の双

方に対応するものでなければならない。

【００１６】すなわち、t_1 点より前段の早い変化に対応する制御と、t_1 点より後段の遅い変化に対応する制御とを同時に行なう必要がある。

【００１７】従来、曝気槽のＤＯ濃度を一定に保つための制御には、曝気槽のＤＯ濃度計の指示値とその目標値の偏差に基づいて送風量を修正するフィードバック制御方法や、このフィードバック制御方法においてさらに上記偏差を汚水流量で修正するカスケード制御方法などが用いられている。

【００１８】

【発明が解決しようとする課題】しかしながら、前者のフィードバック制御において、前述のＤＯ濃度の前段の早い変化に追随させるために制御ゲインを高くすると、後段の遅い変化では過度の応答をしてオーバシュートやリミットサイクル現象（振動）を生じさせる。逆に後段の遅い変化に追随させるために制御ゲインを低くすると、前段の早い変化に追随できず応答遅れが生ずるので、汚水の流入量が日間，週間および季節的に変化する汚水処理プラントの送風量制御には不適当となる。

【００１９】また後者のカスケード制御においては、汚水流量に送風量が比例して増減するので、ＤＯ濃度の早い変化には追随できるが、大雨など汚水流量の増大時間が長時間になった場合や、後段の遅い変化が前段の早い変化とは時刻的に重なった場合には、後段の遅いＤＯ変化に追随できず、過度の応答をしてオーバシュートする原因となっている。

【００２０】本発明はこのような点を考慮してなされたものであり、曝気槽内のＤＯ濃度を常に目標の範囲に保つことができるとともに、過曝気や曝気不足を防止することができる汚水処理プラントの送風量制御装置を提供することを目的とする。

【００２１】

【課題を解決するための手段】本発明は、曝気槽内のＤＯ濃度を一定値に保つよう送風機から曝気槽への送風量を制御する汚水処理プラントの送風量制御装置において、曝気槽内のＤＯ濃度とＤＯ濃度目標値とに基づいて送風量の偏差量を出力するフィードバック制御器と、曝気槽内に流入する汚水の流入流量、その懸濁物濃度、その水温、曝気槽への送風量、および曝気槽内のＤＯ濃度を時系列で記憶するプロセスデータ記憶装置と、プロセスデータ記憶装置からの汚水の流入流量、その懸濁物濃度、その水温および曝気槽への送風量に基づいて、負荷変動時の送風量の補正量を求める第１ニューラルネットワーク機能を有する第１演算手段と、汚水の流入流量、その懸濁物濃度、その水温および曝気槽への送風量に基づいてＤＯ濃度を求める第２ニューラルネットワーク機能を有し、プロセスデータ記憶装置からの情報により学習した後、ＤＯ濃度が目標値となるような送風量を予測し、この予測風量と負荷変動直前の送風量との間の補正量を求めるとともに、汚水の流入流量、その懸濁物濃度、その水温および曝気槽への送風量を入力信号、送風量の補正量を出力信号とする教示信号を第１演算手段に出力して第１ニューラルネットワーク機能の学習を行なう第２演算手段と、第１の演算手段からの送風機の補正量とフィードバック制御器からの偏差量とを加算して送風量を制御する加算器とを、備えたことを特徴とする汚水処理プラントの送風量制御装置である。

【００２２】

【作用】第２演算手段において、プロセスデータ記憶装置からの汚水の流入流量、懸濁物濃度、水温、送風量およびＤＯ濃度に基づいて第２ニューラルネットワーク機能を学習させた後、ＤＯ濃度が目標値となるような送風量を予測し、この予測風量と負荷変動直前の送風量との間の補正量を求める。次に第２演算手段から第１演算手段へ、汚水の流入流量、懸濁物濃度、水温および送風量を入力信号とし、送風量の補正量を出力信号とする教示信号が送られ、この教示信号によって第１演算手段の第１ニューラルネットワークを学習させる。次に、第１演算手段の第１ニューラルネットワーク機能において、プロセスデータ記憶装置からの汚水の流入流量、懸濁物濃度、その水温および送風量に基づいて送風量の補正量を求める。次に加算器において、第１演算手段からの補正量とフィードバック制御器からの偏差量とが加算され、この加算値に基づいて送風機が制御される。

【００２３】

【実施例】以下、図面を参照して本発明の実施例について説明する。図１乃至図３は、本発明による汚泥処理プラントの送風量制御装置の一実施例を示す図である。

【００２４】図１において、汚水は図示しない一次処理工程から流量計１と、水温計２と、懸濁物（以下ＳＳと記す）濃度計３とを有する水路Ａを通って曝気槽４に流入する。曝気槽４内において、汚水は風量計５、送風弁６、送風機７、管路Ｂ、および散気管８を順次通って送入された空気によって曝気され、空気中の酸素による酸化を受けたあと水路Ｃを通って沈殿池９に導かれる。また、沈殿池９内の汚泥は返送汚泥として曝気槽４内に送られ、同時に沈殿池９内の余った汚泥は余剰汚泥として系外に排出される。

【００２５】曝気槽４には、ＤＯ濃度計１０が設置されている。流量計１と、水温計２と、ＳＳ濃度計３と、風量計５と、ＤＯ濃度計１０は、本発明による汚水処理プラントの送風量制御装置１１（一点鎖線で示す）のプロセスデータ記憶装置１２に送られ、それらの時系列データとして貯えられる。

【００２６】次に、送風量制御装置１１について詳述する。送風量制御装置１１は、プロセス記憶装置１２からの汚水の流入流量、ＳＳ濃度、水温、および曝気槽への送風量に基づいて、負荷変動時の送風量の補正量を求める第１ニューラルネットワーク機能（以下、ＮＮＷ－

1）をもった第1演算手段14を有し、この第1演算手段14は第2演算手段15に接続されている。

【0027】第2演算手段15は、汚水の流入流量、SS濃度、水温、および曝気槽への送風量に基づいてDO濃度を求める第2ニューラルネットワーク機能（以下、NNW－2）を有し、プロセス記憶装置12からの情報によりNNW－2の学習が行なわれた後、DO濃度が所定値となる送風量が予測される。また第2演算手段15において、予測送風量と負荷変動直前の送風量との間の補正量が求められ、汚水の流入流量、SS濃度および水温を入力信号、送風量の補正量を出力信号とする教示信号が第1演算手段14に出力され、第1ニューラルネットワーク機能の学習が行なわれる。

【0028】また、送風量制御装置11は、曝気槽4内のDO濃度と、DO濃度目標値とに基づいて送風量の偏差量を出力するフィードバック制御器13を有している。また、第1演算手段14とフィードバック制御器13には、第1演算手段14からの送風機の補正量とフィードバック制御器13からの偏差量とを加算する加算器16が接続されている。また加算器16からの信号は、送風弁6を設定する設定器17に送られるようになっている。

【0029】次にこのような構成からなる本実施例の作用について説明する。

【0030】本発明は、非常時の負荷増大（または減少）時において、曝気槽のDO濃度を所定の目標に保つために、通常時では十分にDO濃度を所定の値に保持できるフィードバック制御を行なっても応答遅れによって十分にはDO濃度を所定の値に保持できない場合、従来手動で介入していた送風量の補正量Gを、正しい補正を行なった時の運転諸データを教示データLとして学習したニューラルネットワークによって算出し、この補正量Gに基づいてフィードバック制御を補填するようにしたものである。

【0031】まず、第1演算手段14の作用について説明する。図2（a）に示すように、SS濃度S_iの急上昇による負荷増大に対し送風量Q_aが手動で操作され、曝気槽のDO濃度C_pがその目標値C_sに十分保持されている場合、送風量Q_aがそれ以前と異なる運転を始めた時刻t_2と通常の運転に復帰した時刻t_3間の汚水流入流量Q_iおよび水温T_i（図示せず）と、図2（a）に示すSS濃度S_iおよび送風量Q_aがプロセスデータ記憶装置12から第1演算手段14に入力される。第1演算手段14において、負荷変動時の送風量補正量Gを出力とするように、後述する第2演算手段15によってNNW－1を学習させ、NNW－1内の各ニューロンの結合強度｛K_i｝、｛K_{jk}｝（ここでiはNNW－1の入力層、jは中間層、kは出力層のニューロン番号である）を決定する。図2（b）は、入出力関係を概念的に示す図である。

【0032】第1ニューラルネットワーク機能（NNW－1）は、図2（b）に示すように、負荷の増大（または減少）時に通常時用のフィードバック制御器13による制御を正しく補填するものであり、後述のように曝気槽内のDO濃度を目標の値に運転することに成功した場合のデータを教示データとし複数回学習させておくことによって、汎化能力を持たせたものである。これによって汚水流入流量、水温、SS濃度など負荷変動の原因がいずれの場合であってもフィードバック制御器13を正しく補填する能力を持たせたものである。

【0033】上記NNW－1に十分な汎化能力を持たせるためには、正しく送風量が運転された場合の教示データを数多く要する。しかしながら、住民の生活や工場の稼動の様に日間または週間の繰返しの短い周期性を示す負荷変動に対しては、運転員の日常の努力によって正しい送風量の運転に成功する機会は多いが、年単位の周期性を持った負荷変動や降雨などの自然条件に支配される確率的な負荷変動に対しては、運転員が経験する機会は少ない。このため正しく送風量が運転された場合の教示データを得ることが非常に難しい。

【0034】そこで、NNW－2を有する第2演算手段15が必要となる。次に第2演算手段15の機能について述べる。

【0035】第2演算手段15は、図3（a）に示すように、流入流量Q_iとSS濃度S_iの急上昇による負荷増大に対し、送風量Q_a（手動または自動）が操作されたが、曝気槽のDO濃度C_pはその目標値C_sと大きくずれてしまった場合、大きくずれたDO濃度C_pを目標値C_sにするためには如何なる送風量であるべきかNNW－2を用いて逆解析的に予測送風量Q_Aを予測する。そのために、まずプロセスデータ記憶装置12から汚水流入流量Q_i、水温T_i、SS濃度S_i、DO濃度C_pおよび送風量Q_aが第2演算手段15に入力される。次に図3（b）に示すように、第2演算手段15において、汚水流入流量Q_i、水温T_i、SS濃度S_iに対し操作量である送風量Q_aを定めた場合、曝気槽のDO濃度がC_pとなるようにニューラルネットNNW－2を学習させ、ニューロン間の結合強度｛K｝を決定する。次いで、図3（c）に示すように、汚水流入流量Q_i、水温T_i、SS濃度S_iとして同じデータを用い、出力のDO濃度が目標の値C_sとなる様な送風量Q_Aを逆解析に予測する。この解析には、従来の諸解析手法を適用できる。第2演算手段15において、このように予測した送風量Q_Aと、図3（a）に示す時刻t_4直前、すなわち負荷の増大が発生する直前の送風量の値Q_{ao}との差$G=Q_A-Q_{ao}$を計算する。この差$G=Q_A-Q_{ao}$が負荷変動時に対応すべき送風量の補正量Gとなる。

【0036】次に汚水流入流量Q_i、水温T_i、SS濃度S_iおよび送風量Q_aを入力信号とし、計算した送風量の補正量Gを出力信号とする教示データLが第2演算

手段１５から第１演算手段１４に入力され、第１演算手段１４のＮＮＷ－１を学習させる。

【００３７】このように、ＮＮＷ－１に汎化能力を十分に持たせ、気象条件のような確率的な負荷変動に対しても、日間変動の様な短い周期性をもった負荷変動と同様に正しく作動させることができる。 ＊

＊【００３８】他方、ＤＯ濃度計の指示値C_pがフィードバック制御器１３に制御周期毎に取り込まれ、次に示す式（１）（２）に基づいて送風機７の送風量の修正量である出力偏差ΔＳが求められる。

【００３９】

$$E_n = C_s - C_p \qquad \cdots\cdots\cdots (1)$$

$$\Delta S = K_p \ (E_n - E_{n-1}) + \frac{h}{I} \cdot E_n \qquad \cdots\cdots\cdots (2)$$

ここでC_s：ＤＯの目標値

E_n：入力偏差

K_p：ｈ、Ｉは制御パラメータで比例ゲイン、制御周期、積分時間

ΔＳ：出力偏差

である。

【００４０】次に前述のように、プロセスデータ記憶装置１２に貯えられた汚水の流入流量Q_iと水温T_iとＳＳ濃度S_iと曝気槽への送風量Q_aの時系列データが、第１演算手段１４に入力される。次に第２演算手段１５によって教示的に学習したＮＮＷ－１によって送風量の補正量Ｇがフィードバック制御器１３の制御周期毎に求められて出力される。

【００４１】次に第１演算手段１４のＮＮＷ－１で求められた送風量の補正量Ｇと、フィードバック制御器１３からの出力である出力偏差ΔＳと、風量計５の信号である送風量Q_aが、ともに加算器１６に送られる。次に加算器１６において、送風量Q_a、出力偏差ΔＳ、および補正量Ｇに基づいて、送風量の修正値であるQ_sが算出され、この修正値Q_sが設定器１７に出力される。そして設定器１７からの信号に基づいて、送風弁６の開閉制御が行なわれ、送風量が制御される。

【００４２】以上説明したように、本実施例によれば、ＮＮＷ－１を有する第１演算手段１４とＮＮＷ－２を有する第２演算手段１５を用いて、フィードバック制御器１３で求められたＤＯ濃度とＤＯ濃度目標値との偏差量を補正することができるので、急な負荷変動時においても、曝気槽内のＤＯ濃度を安定して所定の値に保つことができる。

【００４３】

【発明の効果】以上説明したように、本発明によれば、第２ニューラルネットワーク機能を有する第２演算手段を用いて第１演算手段の第１ニューラルネットワーク機能を学習させ、この第１演算手段で負荷変動時の送風量補正量を求め、この送風量補正量によってフィードバック制御器からの送風量偏差量を補正するので、急な負荷変動時においても過曝気や曝気不足にならずに、曝気槽内のＤＯ濃度を所定の値に安定して維持することができる。

【図面の簡単な説明】

【図１】本発明による汚泥処理プラントの送風量制御装置の一実施例を示す概略系統図。

【図２】第１演算手段の第１ニューラルネットワーク機能の作用説明図。

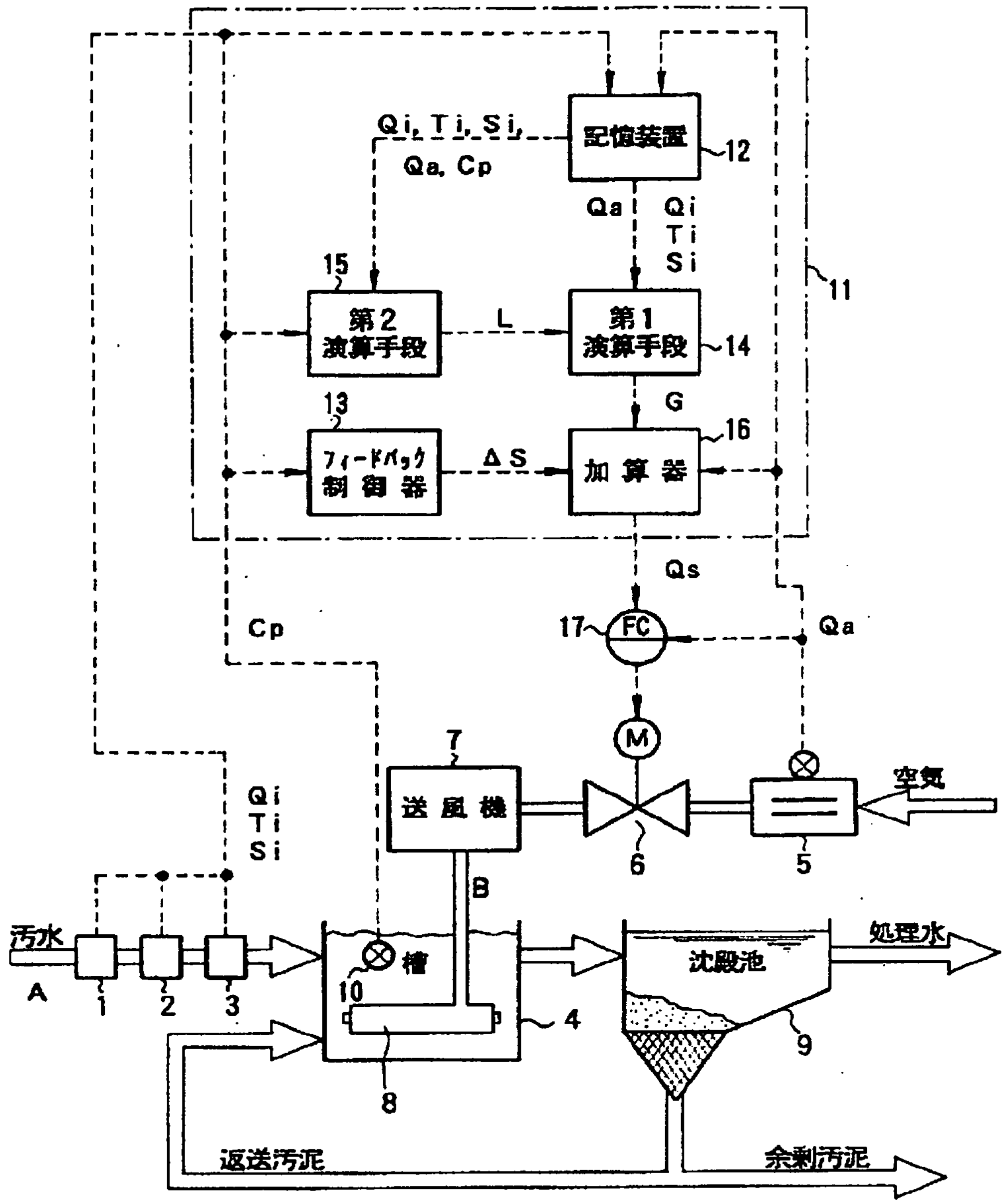
【図３】第２演算手段の第２ニューラルネットワーク機能の作用説明図。

【図４】従来の汚水流入流量のステップ変動に対するＤＯ濃度の実験結果を示すタイムチャート。

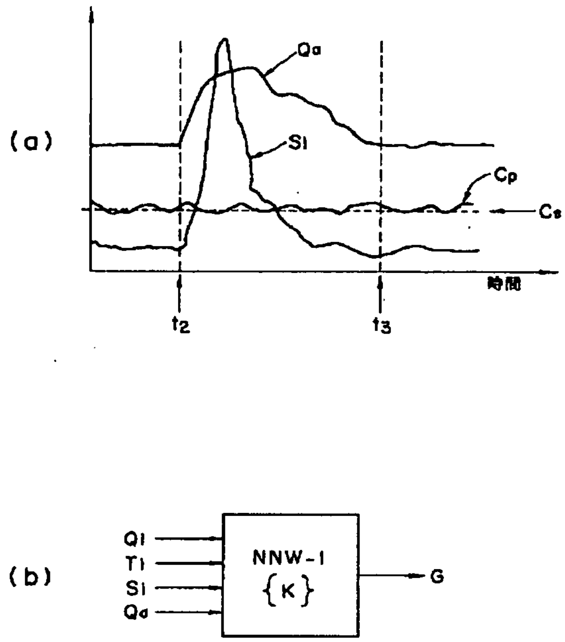
【符号の説明】

１１ 送風量制御装置
１２ プロセスデータ記憶装置
１３ フィードバック制御器
１４ 第１演算手段
１５ 第２演算手段
１６ 加算器
１７ 設定器

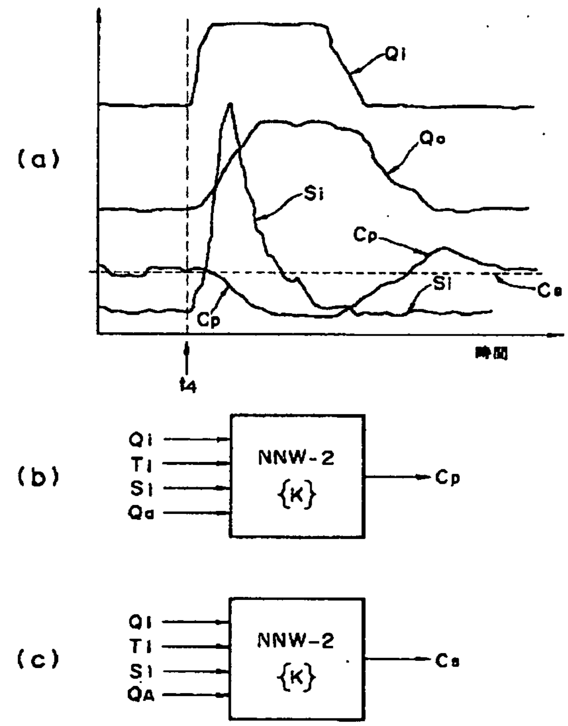
【図1】


記憶装置
12
Qi, Ti, Si,
Qa, Cp
Qa
Qi
Ti
Si
15
第2
演算手段
L
第1
演算手段
14
11
13
フィードバック
制御器
ΔS
加算器
16
G
Qs
17
FC
Qa
Cp
M
7
送風機
6
5
空気
Qi
Ti
Si
B
汚水
A
1
2
3
10
槽
4
8
沈殿池
9
処理水
返送汚泥
余剰汚泥

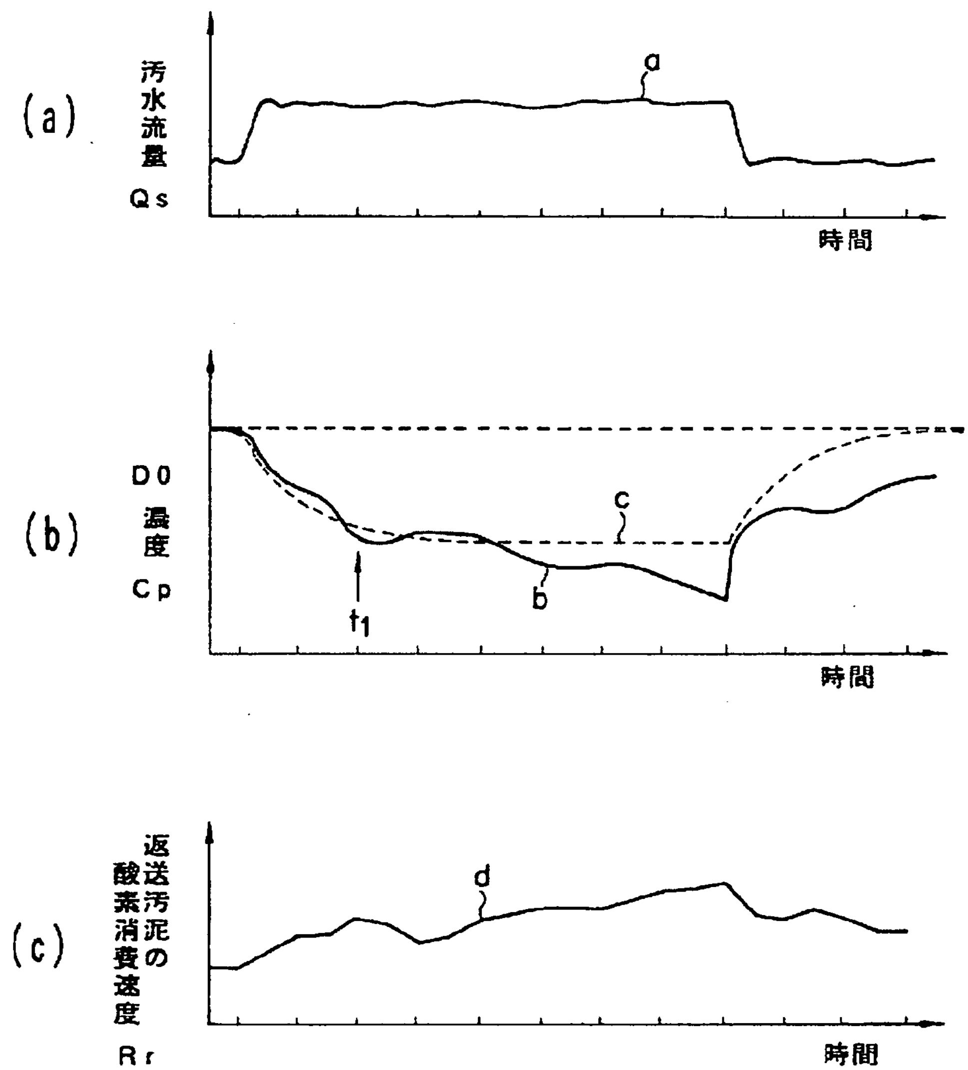
【図2】


(a)
Qa
Si
Cp
Cs
時間
t2
t3
(b)
Qi
Ti
Si
Qa
NNW-1
{K}
G

【図3】


(a)
Qi
Qo
Si
Cp
Si
Cs
Cp
時間
t4
(b)
Qi
Ti
Si
Qa
NNW-2
{K}
Cp
(c)
Qi
Ti
Si
QA
NNW-2
{K}
Cs

【図４】



フロントページの続き

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Partial English translation of JP-A-6-262192 (Ref.7)

(page 2, left column, lines 1 to 27)

[Title]
Blast rate controller for sewage treatment plant

[Claims]
1. A blast rate controller for sewage treatment plant which controls blast rate from a fan to an aeration tank so as to keep DO concentration in the aeration tank to be constant value, comprising:

a feedback controller for outputting deviation quantity of the blast rate based on the DO concentration and target value of the DO concentration in the aeration tank; a process data storage device for storing the flow rate of the sewage flowing in the aeration tank 4, the concentration of suspended solids of the sewage, the temperature of the sewage, the blast rate into the aeration tank, and the DO concentration in the aeration tank, in chronologic order;

a first arithmetic means having a first neural network function for calculating the correction rate of the blast rate at the time of the fluctuation in load based on the flow rate of the sewage, the concentration of suspended solids of the sewage, the temperature of the sewage, the blast rate into the aeration tank from the process data storage device;

a second arithmetic means having a second neural network function for calculating the DO concentration based on the flow rate of the sewage, the concentration of suspended solids of the sewage, the temperature of the sewage, the blast rate into the aeration tank, for learning the first neural network function by learning the information from the process data storage device, susequently predicting such blow rate that the DO concentration becomes the target value thereof, calculating the correction rate between the predicted blow rate and the just former blast rate, and outputting a teaching signal into the first arithmetic means, which uses the flow rate of the sewage, the concentration of suspended solids of the sewage, the temperature of the sewage, the blast rate into the aeration tank as output signals thereof, and the correction rate of the blast rate as an input signal thereof; and

an adder for controlling the blow rate by adding the correction rate of the fun from the first arithmetic means, and the deviation quantity from the feedback controller.

PA-32674
31151 ⑦

BLAST RATE CONTROLLER FOR SEWAGE TREATMENT PLANT

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Publication date: 1994-09-20
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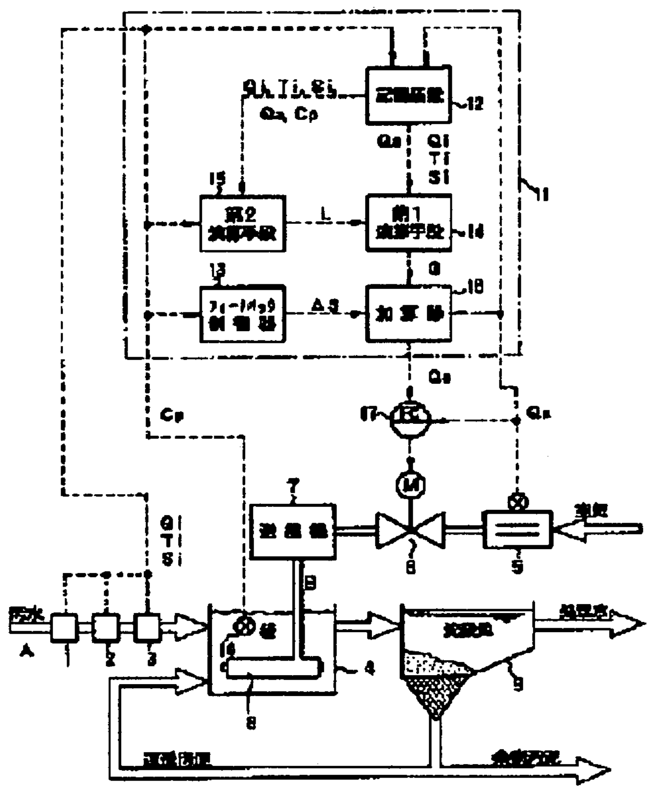
Applicant: TOKYO SHIBAURA ELECTRIC CO
Classification:
- international: *C02F3/12;* **C02F3/12;** (IPC1-7): C02F3/12
- European:
Application number: JP19930053852 19930315
Priority number(s): JP19930053852 19930315

Abstract of **JP6262192**

PURPOSE:To stably maintain the DO concn. of an aeration tank without generating overaeration and underaeration even in the vent of an abrupt fluctuation in load by computing the correction rate of a blast rate at the time of the fluctuation in load, thereby correcting the deviation quantity of the blast rate in the case of controlling of the blast rate to the aeration tank. CONSTITUTION:This blast rate controller 11 controls the blast rate from a fan 7 to the aeration tank 4 so as to maintain the DO concn. of the aeration tank 4 at a specified value. The deviation quantity of the blast rate is calculated by a feedback controller 13 in accordance with the DO concn. of the aeration tank 4 and the target value thereof. On the other hand, the flow rate of the sewage in the aeration tank 4, the concn. of suspended solids, the temp. of the water, the blast rate and the DO concn. are respectively stored by a process data storage device 12. The correction rate of the blast rate at the time of the fluctuation in load is computed by a first arithmetic means 14 in accordance with the stored data. Further, the correction rate between the predicted blast rate and the blast rate just before the fluctuation in load is computed by a second arithmetic means 15. The deviation quantity of the blast rate and the correction rate are added by an adder 16 and the blast rate is thus controlled.



* NOTICES *

CLAIMS

[Claim(s)]

[Claim 1] In the blast weight control unit of the sewage plant which controls the blast weight from a blower to into an aerator to maintain DO concentration in an aerator at constant value The feedback control machine which outputs the amount of deflection of blast weight based on DO concentration and DO concentration desired value in an aerator, The process-data storage which memorizes the input flow rate of the sanitary sewage which flows in an aerator, its suspended solid concentration, its water temperature, the blast weight to an aerator, and DO concentration in an aerator by time series, A 1st operation means to have the 1st neural network function to calculate the amount of amendments of the blast weight at the time of a load effect, based on the blast weight to the input flow rate, its suspended solid concentration, its water temperature, and aerator of the sanitary sewage from process-data storage, It has the 2nd neural network function to ask for DO concentration based on the blast weight to the input flow rate, its suspended solid concentration, its water temperature, and aerator of the sanitary sewage. After learning using the information from process-data storage, while predicting blast weight from which DO concentration serves as desired value and calculating the amount of amendments between this prediction airflow and the blast weight in front of a load effect A 2nd operation means to output the instruction signal which makes an output signal an input signal and the amount of amendments of blast weight for the blast weight to the input flow rate, its suspended solid concentration, its water temperature, and aerator of the sanitary sewage to the 1st operation means, and to learn the 1st neural network function, The blast weight control unit of the sewage plant characterized by having the adder which adds the amount of amendments of the blower from the 1st operation means, and the amount of deflection from a feedback control machine, and controls blast weight.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the blast weight control unit for holding uniformly DO concentration of the aerator of the sewage plant which used active sludge.
[0002]
[Description of the Prior Art] The sewage plant which purifies sanitary sewage, such as city sewage and industrial waste water, using active sludge usually consists of an aerator and a settling basin (final settling tank).
[0003] After primary treatment of the sanitary sewage collected from various generation sources is carried out in primary treatment processes, such as grit, pre-aeration, and pre-precipitate, secondary treatment of it is carried out in this sewage plant.
[0004] That is, the sanitary sewage which received primary treatment carries out mixed contact with the returned sludge returned from the settling basin in the aerator of a sludge-disposal plant. Next, the oxygen and the organic substance in the sanitary sewage by which aeration was carried out are absorbed by active sludge (it is written as sludge below), oxidation reaction arises, and the sanitary sewage is purified by this.
[0005] Moreover, while increasing sludge by oxidation reaction, carrying out solid liquid separation of the increased sludge in a settling basin and returning most to an aerator as returned sludge, the increment by growth is drawn out as excess sludge, and is discharged out of a system.
[0006] In the above water treatment plants, the effectiveness of purification, stability, and the energy expenditure of a blower are influenced according to the conditions of aeration, i.e., the dissolved oxygen (it outlines Following DO) concentration of an aerator.
[0007] Therefore, in order to raise the effectiveness of purification, and to prevent fault aeration and to reduce the consumption energy of operation, it is necessary to maintain DO concentration of an aerator at a fixed value.
[0008] On the other hand, DO concentration of an aerator changes with the property of the inflow sanitary sewage and the conditions of operation other than blast weight, and changes with the load effects and water temperature of the flow rate and suspended solid concentration of the inflow sanitary sewage a lot especially.
[0009] To drawing 4 , it is the amount Qs of sanitary sewage of an inflow here. DO concentration Cp when changing in the shape of a step in the sewage plant which purifies city sewage An example of the experimental result which measured change is shown. The continuous line a of drawing 4 (a) is the sanitary-sewage flow rate Qs. Change is shown and the continuous line b of drawing 4 (b) is the DO concentration Cp of the center of abbreviation of an aerator. Change is shown about the case where it was fixed in blast weight and a returned sludge flow rate, and operates.
[0010] As shown in drawing 4 (a), it is the sanitary-sewage flow rate Qs. By the load of a suspended solid becoming high if it increases, and consuming oxygen for oxidation, DO concentration is begun, and dives, and it is a certain time amount after, t1 [i.e.,]. It is falling slowly after a point. This is t1. It is because the devices in which DO concentration changes

differ in the preceding paragraph and the latter part of a point.
[0011] That is, in the preceding paragraph, it is the sanitary-sewage flow rate Qs. A suspended solid burden increases according to increase, and in order to oxidize the suspended solid absorbed by sludge, DO concentration falls. Since the concentration of sludge will be reduced if a flow rate increases as furthermore shown in drawing 4 (a), DO concentration is low a little rather than DO concentration amended to the sludge concentration regularity shown with a broken line c (drawing 4 (b)).
[0012] t1 In addition to the device in the preceding paragraph, in the latter part, the following two devices work further from a point.
[0013] Namely, t1 DO concentration falls rapidly immediately after a point because the sludge of an aerator flows into a settling basin, the amount of sludge of a settling basin increases and returned sludge concentration becomes high according to increase of a sanitary-sewage flow rate. For this reason, the returned sludge of high concentration flows into an aerator, the sludge concentration (it outlines Following MLSS) of an aerator becomes high, and the device in which the consumption of oxygen increases works.
[0014] Other devices are t1. The phenomenon in which DO concentration is falling slowly on the whole in the latter part from the point is explained. That is, the suspended solid absorbed by sludge according to increase of a suspended solid load does not oxidize completely within the residence time of an aerator, but the device in which this is accumulated gradually works including the suspended solid which should still oxidize in returned sludge. Moreover, the continuous line d of drawing 4 (c) shows the temporal response of the oxygen consumption coefficient (it outlines Following Rr) of returned sludge.
[0015] Thus, the blast weight control unit for maintaining DO concentration of an aerator at a target value to disturbance (increase of a sanitary-sewage flow rate) is t1. It must correspond to the both sides of the change device of DO concentration of the preceding paragraph of a point, and the latter part.
[0016] Namely, t1 The control corresponding to change with the preceding paragraph earlier than a point, and t1 It is necessary to perform control corresponding to a late latter change to coincidence from a point.
[0017] The feedback control approach which corrects blast weight based on the deflection of the indicated value and desired value of DO densimeter of an aerator, the cascade control approach which modifies the above-mentioned deflection by the sanitary-sewage flow rate in this feedback control approach are used for control for keeping DO concentration of an aerator constant conventionally.
[0018]
[Problem(s) to be Solved by the Invention] However, in the former feedback control, if control gain is made high in order to make it follow in footsteps of early change of the preceding paragraph of the above-mentioned DO concentration, in a late latter change, too much response will be carried out and overshoot and a limit-cycle phenomenon (vibration) will be produced. Conversely, if control gain is made low in order to make it follow in footsteps of late change [latter], since it cannot follow in footsteps of early change of the preceding paragraph but response delay will arise, the inflow of the sanitary sewage becomes unsuitable during a day at a week and blast weight control of a sewage plant which changes seasonally.
[0019] Moreover, in the latter cascade control, although it could follow in footsteps of early change of DO concentration since blast weight fluctuated in proportion to the sanitary-sewage flow rate, when the increase time amount of sanitary-sewage flow rates, such as heavy rain, turned into long duration, or when a late latter change laps in [an early change of the preceding paragraph] time of day, it cannot follow in footsteps of DO change with the late latter part, but has become the cause which carries out too much response and overshoots.
[0020] While this invention is made in consideration of such a point and always being able to maintain DO concentration in an aerator at the range of target, it aims at offering the blast weight control unit of a sewage plant which can prevent fault aeration and the lack of

aeration.
[0021]
[Means for Solving the Problem] In the blast weight control unit of the sewage plant which controls the blast weight from a blower to an aerator so that this invention maintains DO concentration in an aerator at constant value The feedback control machine which outputs the amount of deflection of blast weight based on DO concentration and DO concentration desired value in an aerator, The process-data storage which memorizes the input flow rate of the sanitary sewage which flows in an aerator, its suspended solid concentration, its water temperature, the blast weight to an aerator, and DO concentration in an aerator by time series, A 1st operation means to have the 1st neural network function to calculate the amount of amendments of the blast weight at the time of a load effect, based on the blast weight to the input flow rate, its suspended solid concentration, its water temperature, and aerator of the sanitary sewage from process-data storage, It has the 2nd neural network function to ask for DO concentration based on the blast weight to the input flow rate, its suspended solid concentration, its water temperature, and aerator of the sanitary sewage. After learning using the information from process-data storage, while predicting blast weight from which DO concentration serves as desired value and calculating the amount of amendments between this prediction airflow and the blast weight in front of a load effect A 2nd operation means to output the instruction signal which makes an output signal an input signal and the amount of amendments of blast weight for the blast weight to the input flow rate, its suspended solid concentration, its water temperature, and aerator of the sanitary sewage to the 1st operation means, and to learn the 1st neural network function, It is the blast weight control unit of the sewage plant characterized by having the adder which adds the amount of amendments of the blower from the 1st operation means, and the amount of deflection from a feedback control machine, and controls blast weight.
[0022]
[Function] In the 2nd operation means, after making the 2nd neural network function learn based on the input flow rate, the suspended solid concentration, the water temperature, blast weight, and DO concentration of the sanitary sewage from process-data storage, blast weight from which DO concentration serves as desired value is predicted, and the amount of amendments between this prediction airflow and the blast weight in front of a load effect is calculated. Next, the instruction signal which makes an input signal the input flow rate, the suspended solid concentration, the water temperature, and blast weight of the sanitary sewage from the 2nd operation means to the 1st operation means, and makes the amount of amendments of blast weight an output signal is sent, and the 1st neural network of the 1st operation means is made to learn with this instruction signal. Next, in the 1st neural network function of the 1st operation means, the amount of amendments of blast weight is calculated based on the input flow rate, the suspended solid concentration, its water temperature, and blast weight of the sanitary sewage from process-data storage. Next, in an adder, the amount of amendments from the 1st operation means and the amount of deflection from a feedback control machine are added, and a blower is controlled based on this aggregate value.
[0023]
[Example] Hereafter, the example of this invention is explained with reference to a drawing. Drawing 1 thru/or drawing 3 are drawings showing one example of the blast weight control unit of the sludge-disposal plant by this invention.
[0024] In drawing 1 , the sanitary sewage flows into an aerator 4 through the channel A which has a flowmeter 1, a water thermometer 2, and the suspended solid (it is described as Following SS) concentration meter 3 from the primary treatment process which is not illustrated. Aeration of the sanitary sewage is carried out by the air by which the connoisseur was fed one by one in the aerator 4 in a airflow meter 5, the ventilation valve 6, the blower 7, Duct B, and the powder trachea 8, and after it receives oxidation by the oxygen in air, it is led to a settling basin 9 through Channel C. Moreover, the sludge in a settling basin 9 is sent in an aerator 4 as returned sludge, and the sludge with which it remained in the settling basin

9 in coincidence is discharged out of a system as excess sludge.
[0025] The DO concentration meter 10 is installed in the aerator 4. A flowmeter 1, a water thermometer 2, the SS concentration meter 3, a airflow meter 5, and the DO concentration meter 10 are seen off in the process-data store 12 of the blast weight control device 11 (an alternate long and short dash line shows) of the sewage plant by this invention, and are stored as those time series data.
[0026] Next, the blast weight control unit 11 is explained in full detail. The blast weight control unit 11 has the 1st operation means 14 with the 1st neural network function (the following, NNW-1) to calculate the amount of amendments of the blast weight at the time of a load effect, based on the input flow rate of the sanitary sewage from the process storage 12, SS concentration, water temperature, and the blast weight to an aerator, and this 1st operation means 14 is connected to the 2nd operation means 15.
[0027] After the 2nd operation means 15 has the 2nd neural network function (the following, NNW-2) to ask for DO concentration based on the input flow rate of the sanitary sewage, SS concentration, water temperature, and the blast weight to an aerator and study of NNW-2 is performed by the information from the process storage 12, the blast weight from which DO concentration serves as a predetermined value is predicted. Moreover, in the 2nd operation means 15, the amount of amendments between prediction blast weight and the blast weight in front of a load effect is calculated, the instruction signal which makes an output signal an input signal and the amount of amendments of blast weight for the input flow rate, SS concentration, and the water temperature of the sanitary sewage is outputted to the 1st operation means 14, and study of the 1st neural network function is performed.
[0028] Moreover, the blast weight control unit 11 has the feedback control machine 13 which outputs the amount of deflection of blast weight based on DO concentration and DO concentration desired value in an aerator 4. Moreover, the adder 16 adding the amount of amendments of the blower from the 1st operation means 14 and the amount of deflection from the feedback control machine 13 is connected to the 1st operation means 14 and the feedback control machine 13. Moreover, the signal from an adder 16 is sent to the setter 17 which sets up the ventilation valve 6.
[0029] Next, the operation of this example which consists of such a configuration is explained.
[0030] In order that this invention may maintain DO concentration of an aerator at a predetermined target at the time of the load increase in an emergency (or reduction) Usually, even if it performs feedback control which can fully hold DO concentration to a predetermined value in the time, when DO concentration cannot fully be held to a predetermined value according to response delay, It computes by the neural network who learned many operation data when performing right amendment for the amount G of amendments of the blast weight which was intervening manually conventionally as instruction data L, and feedback control is filled up based on this amount G of amendments.
[0031] First, an operation of the 1st operation means 14 is explained. As shown in drawing 2 (a), it is the SS concentration Si. It is blast weight Qa to the load increase by sudden rise. It is operated manually. DO concentration Cp of an aerator The desired value Cs When held enough, Blast weight Qa Time of day t2 which began different operation from it or before Time of day t3 which returned to the usual operation Sanitary-sewage inflow flow Q [of a between] i And water temperature Ti (not shown) SS concentration Si shown in drawing 2 (a) And blast weight Qa It is inputted into the 1st operation means 14 from the process-data storage 12. In the 1st operation means 14, with a 2nd operation means 15 to mention later, NNW-1 is made to learn and the bond strength {Ki} of each neurone in NNW-1 and {Kjk} (i is [an interlayer and k of the input layer of NNW-1 and j] the neurone numbers of an output layer here) are determined so that the amount G of blast weight amendments at the time of a load effect may be considered as an output. Drawing 2 (b) is drawing showing input/output relation notionally.
[0032] The 1st neural network function (NNW-1) gives generalization capacity by usually filling up correctly control with the feedback control machine 13 for the time at the time of

increase (or reduction) of a load, using the data at the time of succeeding in operating DO concentration in an aerator to a target value like the after-mentioned as instruction data, and carrying out multiple-times study, as shown in drawing 2 (b). By this, even if it is the case where the cause of load effects, such as a sanitary-sewage input flow rate, water temperature, and SS concentration, is any, the capacity which fills up the feedback control machine 13 correctly is given.

[0033] In order to give sufficient generalization capacity for the above-mentioned NNW-1, many instruction data when blast weight is operated correctly are required. However, although there are many opportunities to succeed in operation of right blast weight by everyday efforts of an operating staff to the load effect which shows the short periodicity of a repetition of between days or a week like a life of residents or operation of works, there are few opportunities for an operating staff to experience to the probable load effect governed by natural conditions with the periodicity of a year unit, such as a load effect and a rainfall. For this reason, it is very difficult to obtain instruction data when blast weight is operated correctly.

[0034] Then, a 2nd operation means 15 to have NNW-2 is needed. Next, the function of the 2nd operation means 15 is described.

[0035] The 2nd operation means 15 is inflow flow Q i, as shown in drawing 3 (a). Although blast weight Qa (hand control or automatic) was operated to the load increase by sudden rise of the SS concentration Si DO concentration Cp of an aerator The desired value Cs DO concentration Cp which shifted greatly when shifted greatly Desired value Cs In order to carry out, it should be what kind of blast weight, or NNW-2 are used, and it is the prediction blast weight QA in reverse analysis. It predicts. Therefore, they are sanitary-sewage inflow flow Q i, water temperature Ti, the SS concentration Si, and the DO concentration Cp from the process-data storage 12 first. It calls and is blast weight Qa. It is inputted into the 2nd operation means 15. Next, as shown in drawing 3 (b), it sets for the 2nd operation means 15, and they are sanitary-sewage inflow flow Q i, water temperature Ti, and the SS concentration Si. Blast weight Qa which it receives and is a control input When it sets, DO concentration of an aerator is Cp. Neural network NNW-2 are made to learn so that it may become, and the bond strength between neurone {K} is determined. Subsequently, as shown in drawing 3 (c), they are sanitary-sewage inflow flow Q i, water temperature Ti, and the SS concentration Si. It carries out, the same data are used and DO concentration of an output is the target value Cs. Blast weight QA which becomes It predicts to reverse analysis. Many conventional analysis technique is applicable to this analysis. Blast weight QA predicted in this way in the 2nd operation means 15 Time of day t4 shown in drawing 3 (a) Difference G=QA-Qao with the value Qao of the last, i.e., just before increase of a load occurs, blast weight is calculated. This difference G=QA-Qao serves as the amount G of amendments of the blast weight which should correspond at the time of a load effect.

[0036] Next, sanitary-sewage inflow flow Q i, water temperature Ti, and SS concentration Si And blast weight Qa The instruction data L which consider as an input signal and make an output signal the amount G of amendments of the calculated blast weight are inputted into the 1st operation means 14 from the 2nd operation means 15, and NNW-1 of the 1st operation means 14 is made to learn.

[0037] Thus, generalization capacity can fully be given to NNW-1 and it can be made to operate correctly like a load effect with short periodicity like a diurnal variation also to a probable load effect like a meteorological condition.

[0038] On the other hand, indicated value CP of DO densimeter It is incorporated by the feedback control machine 13 for every control period, and output deflection deltaS which is the amount of corrections of the blast weight of a blower 7 is called for based on the formula (1) shown below and (2).

[0039]

En =Cs-Cp ...... (1)

$$\Delta S = K_p \left(E_n - E_{n-1}\right) + \frac{h}{I} \cdot E_n \quad \cdots\cdots\cdots (2)$$

It is Cs here. : Desired value En of DO : Input deflection Kp : h and I are proportional gain, a control period, and reset-time deltaS:output deflection in a control parameter.
[0040] Next, inflow flow Q [of the sanitary sewage stored in the process-data storage 12 as mentioned above] i Water temperature Ti SS concentration Si Blast weight Qa to an aerator Time series data are inputted into the 1st operation means 14. Next, the amount G of amendments of blast weight is calculated and outputted for every control period of the feedback control machine 13 by NNW-1 learned in instruction with the 2nd operation means 15.
[0041] Next, blast weight Qa which is output deflection deltaS which is an output from the amount G of amendments and the feedback control machine 13 of blast weight which were called for by NNW-1 of the 1st operation means 14, and the signal of a airflow meter 5 It is sent to both the adders 16. Next, Qs which is the adjusted value of blast weight in an adder 16 based on blast weight Qa, output deflection deltaS, and the amount G of amendments It is computed and is this adjusted value Qs. It is outputted to a setter 17. And based on the signal from a setter 17, closing motion control of the ventilation valve 6 is performed, and blast weight is controlled.
[0042] Since the amount of deflection of DO concentration and DO concentration desired value which were calculated with the feedback control vessel 13 can be amended using a 1st operation means 14 to have NNW-1, and a 2nd operation means 15 to have NNW-2 according to this example as explained above, it is stabilized at the time of a sudden load effect, and DO concentration in an aerator can be maintained at a predetermined value at it.
[0043]
[Effect of the Invention] According to this invention, the 1st neural network function of the 1st operation means is made to learn using a 2nd operation means to have the 2nd neural network function, as explained above. Since the amount of blast weight amendments at the time of a load effect is calculated with this 1st operation means and this amount of blast weight amendments amends the amount of blast weight deflection from a feedback control machine, DO concentration in an aerator can be stabilized and maintained to a predetermined value, without becoming fault aeration and the lack of aeration at the time of a sudden load effect.

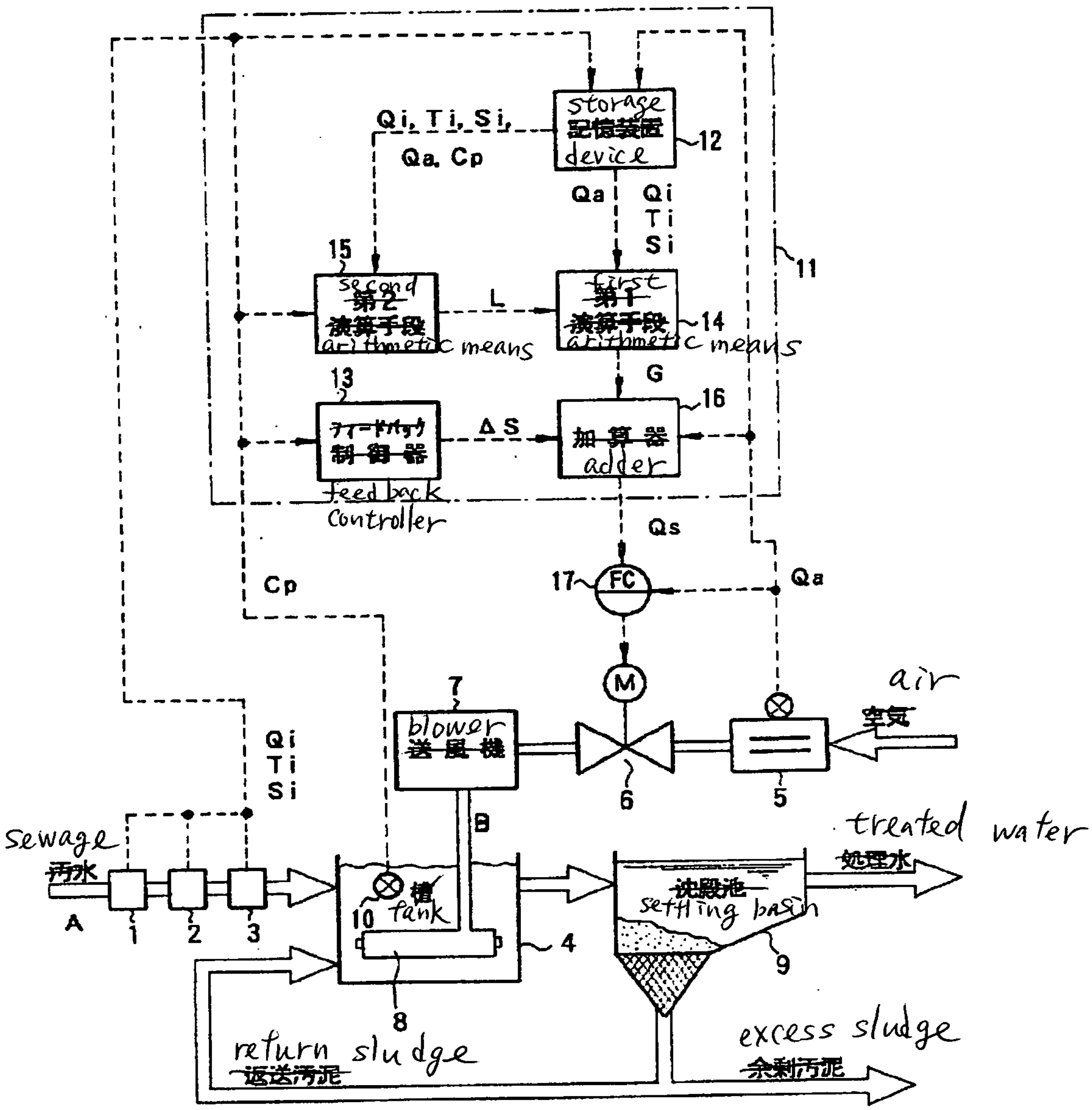
[Translation done.]

DESCRIPTION OF DRAWINGS

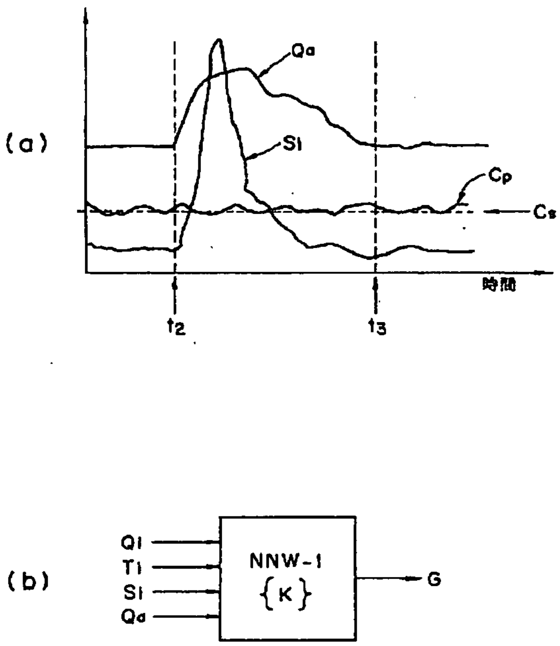
[Brief Description of the Drawings]
[Drawing 1] The outline schematic diagram showing one example of the blast weight control unit of the sludge-disposal plant by this invention.
[Drawing 2] The operation explanatory view of the 1st neural network function of the 1st operation means.
[Drawing 3] The operation explanatory view of the 2nd neural network function of the 2nd operation means.
[Drawing 4] The timing diagram which shows the experimental result of DO concentration to step fluctuation of the conventional sanitary-sewage input flow rate.
[Description of Notations]
11 Blast Weight Control Unit
12 Process-Data Storage
13 Feedback Control Machine
14 1st Operation Means
15 2nd Operation Means
16 Adder
17 Setter

[Translation done.]

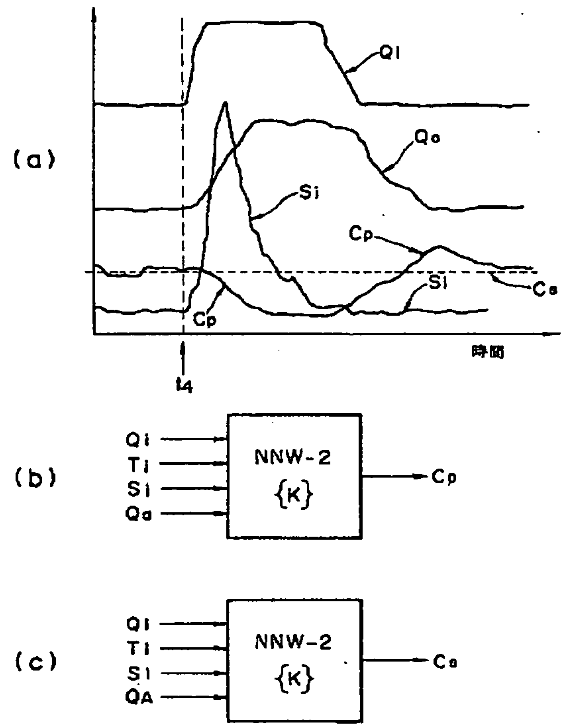
~~【図1】~~ Fig. 1


storage
~~記憶装置~~
device
12
Qi, Ti, Si,
Qa, Cp
Qa
Qi
Ti
Si
15
second
~~第2~~
~~演算手段~~
arithmetic means
L
first
~~第1~~
~~演算手段~~
arithmetic means
14
11
13
G
16
~~フィードバック~~
~~制御器~~
feed back
controller
ΔS
~~加算器~~
adder
Qs
Cp
17
FC
Qa
M
air
~~空気~~
7
blower
~~送風機~~
6
5
Qi
Ti
Si
B
sewage
~~汚水~~
A
1
2
3
~~槽~~
tank
10
4
treated water
~~処理水~~
~~沈殿池~~
settling basin
9
8
excess sludge
~~余剰汚泥~~
return sludge
~~返送汚泥~~

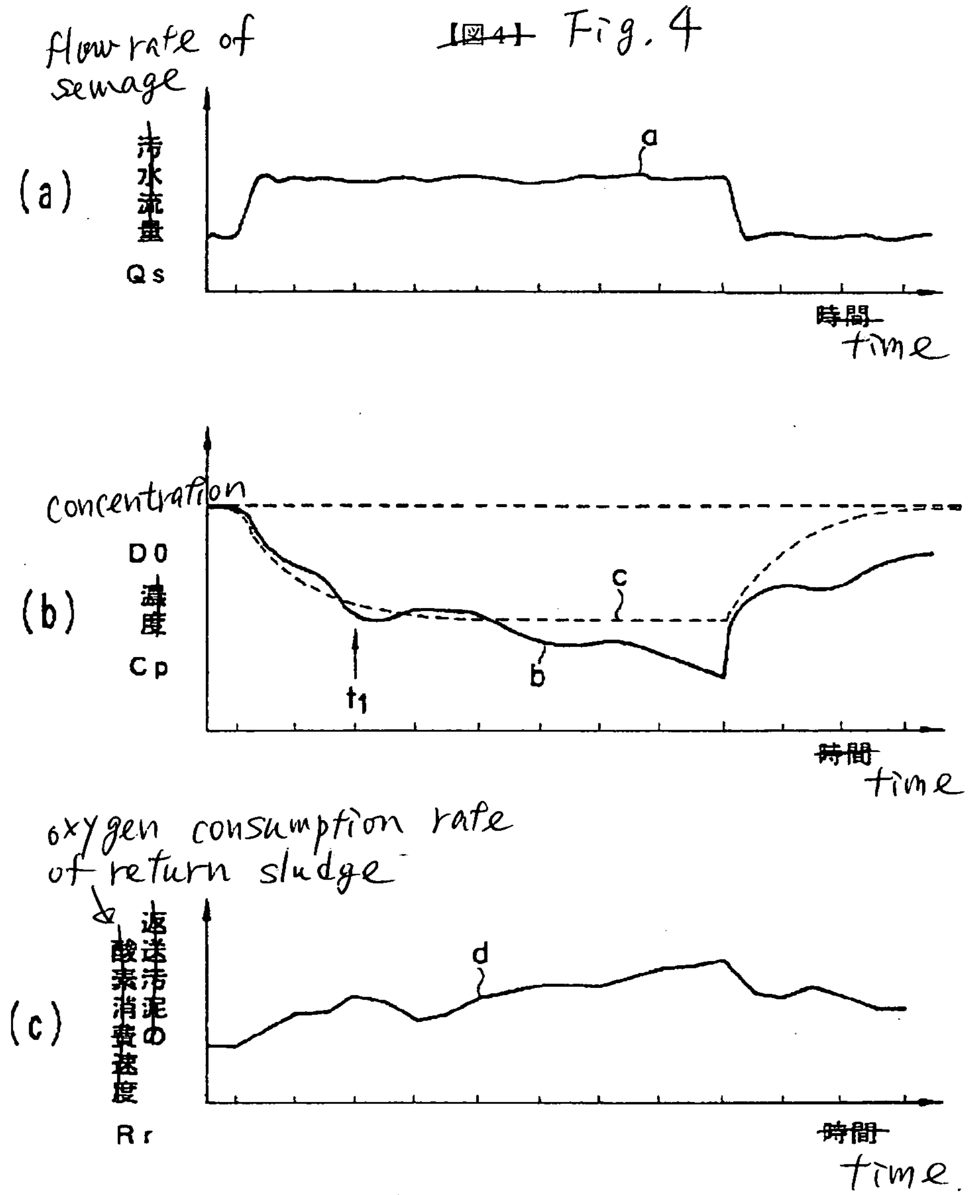
~~【図２】~~ Fig. 2



~~【図３】~~ Fig. 3



~~【図4】~~ Fig. 4


flow rate of sewage
(a)
汚水流量
Qs
a
~~時間~~ time
concentration
(b)
DO濃度
Cp
c
b
t_1
~~時間~~ time
oxygen consumption rate of return sludge
(c)
返送汚泥の酸素消費速度
Rr
d
~~時間~~ time